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Research-in-Progress

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Abstract

The emergence and growing interest in Artificial Intelligence (AI) will have increasing societal implications influencing, the responsibilities of decision-makers and policy analysts. Although an extensive body of literature relating to AI techniques already exists, this is not the case for AI adoption in organisations. This research-in-progress seeks to propose a research framework for AI adoption at firm level. To do so, two popular theories are considered: The Technology-Organisations-Environment (TOE) framework, and Diffusion of Innovation theory (DOI). This paper presents an in-depth interpretation of these theories for the adoption of AI technologies and proposes an AI adoption framework at firm level. A mixed methods research approach is proposed to test and validate the framework. Further work in this project will involve developing the research instrument for data collection via a survey targeted at firms.

Keywords: Artificial Intelligence, AI readiness, TOE, DOI, adoption

Introduction

Artificial intelligence (AI) is a broad subject where a range of terms such as 'machine intelligence,' 'intelligence agents,' 'intelligent behaviour,' 'intelligent systems' and 'algorithms' have been used in its definition. Previously, AI was considered as machines that can think like humans, reason and make decisions, and this perspective has advanced to also consider general human-level AI such as: acts like a human or acts and interprets the world like a human (Russell et al. 2003).

According to Purdy and Daugherty (2016), recent developments in machine learning, expert systems, natural language processing, speech recognition, deep learning and robotics have the most significant impact on AI and business. In this regard, AI has emerged to improve decision making, ecosystems, and re-creation of the customer experience (Gartner, 2017a). The field of AI has become an active area of research in numerous fields and industries including engineering (Pham et al.1999), science (Cartwright, 1997), education (Lajoie & Vivet, 2002), medicine (Ramesh et al. 2004), business, accounting, finance, marketing, economics, and law (Rauch-Hindin, 1986). It is already being applied to such endeavours as the self-driving car, healthcare, and new media (Bollier, 2017). However, while there have been significant reports of AI in the literature (eg Aghion et al. 2017; Fernald & Jones, 2014; Purdy &

Daugherty, 2016) this has not been the case for AI readiness factors for preparing organisations to adopt AI. In particular, AI will play a significant role in the economic growth of countries such as the US (Makridakis, 2017), China (Li, 2017) and India (Vempati, 2016). A recent report by PwC, estimated that the potential contribution of AI to the global economy will increase by 14% (15.7 trillion USD) by 2030. Another PwC report expects China and the US to have the most significant gains from AI, enhancing their GDPs by 26.1% and 14.5%, respectively (Rao, 2016). It has already had substantial economic impacts, especially within the financial services, healthcare and ICT industries (Purdy & Daugherty, 2016). Major competitors in the AI industry such as Google, Amazon, IBM, Facebook, and Apple (Jang, 2017) are thus competing to gain competitive advantage and market share by leading the advancement of AI (Infosys, 2016).

Global Enterprise (Evans & Gawer, 2016) reported that the number of articles on AI and business strategy grew six-fold between 2013 and 2016. In addition, AI is expected to be pervasive in almost every new software product and related services by 2020 (Gartner, 2017b). While various aspects of AI technology have been around for decades, increased network and data processing speeds and advances in hardware have brought AI to the commercial level. Although the demand for innovation and the link between technology and business is developing rapidly (Whinston & Geng, 2004), most AI technology today is still considered to be fairly weak (Lu et al. 2017).

To date, a considerable amount of empirical IS research has focused on IT adoption at the organisational level (Aboelmaged, 2014; Gopalakrishnan & Damanpour, 2006; Yang et al.2015). Over the last three decades or so, we have seen IT being studied firstly for creating competitive advantage then for maintaining and sustaining that advantage. Various theories such as DOI (Rogers, 1995) were applied to understand this phenomenon (Oliveira & Martins, 2011). Knight (2015) claimed that bringing AI into an organisation or workplace can increase productivity and help people make better, faster decisions. However, getting everyone to buy into the idea is a challenge. According to a report by Gartner (2017a), 59% of organisations are still gathering information about whether to adopt AI, and only 6% have deployed AI technology. Another study by the Garter group (2017a) states that how to adopt AI into a business strategy is unclear in terms of enterprise adoption, even though the risk of ignoring AI altogether is much higher. Thus, both the lack of IS research addressing AI adoption and the growing interest in AI are the motivations for investigating the challenges to businesses when deploying AI to create competitive advantage. This research aims to investigate the challenges of AI adoption from an IS perspective. In particular, this research-in-progress paper addresses the following research question:
What factors impact an organisation's readiness for AI adoption?

The next section presents the literature review containing the theoretical foundation of IS to provide a theoretical framework for AI adoption and discussion of e-readiness factors which influence businesses' readiness to adopt AI. The third section presents the hypotheses and a proposed AI adoption framework at firm level. The last section includes the proposed methodology and the future work of this project.

Theoretical Foundation

Adoption of innovation and e-readiness have been studied at either an individual level (Oliveira & Martins, 2011) or at firm level (Aboelmaged, 2014). Several electronic readiness (e-readiness) or readiness models have been proposed and applied to improve competitiveness and maintain resources efficiently (Alshawi,2007; Ruikar et al. 2006). Numerous domains have been studied and e-readiness models have been developed at firm level to allow firms to benefit from e-innovation. For example, e-maintenance (Aboelmaged, 2014), cloud computing (Yang et al. 2015), e-marketing (Duan, 2010; Yan et al.2009; Zhai, 2010), and e-business (Ifinedo, 2005; Molloa et al. 2010). The term "e-readiness" has been defined as willingness of individuals or organisations to participate in organisational development (Alshawi,2007). Findings from the literature on e-readiness have shown different factors that need to be considered when carrying out new innovation adoption. Technology factors, including relative advantage, and compatibility have the ability to positively influence new technology adoption (Aboelmaged, 2014; Hung, 2014; Idris, 2015; Ifinedo, 2005; Yang et al. 2015). For the organisation

factors top management support (Ifinedo, 2005;Yan et al. 2009), and firm size (Aboelmaged, 2014; Duan, 2010; Molla et al.2010;) are the three characteristics that can significantly influence the e-readiness of IS. Competitive pressure and government regulatory issues are the main environmental factors that can affect new innovation adoption (Aboelmaged, 2014; Hung, 2014; Idris, 2015; Ifinedo, 2005; Yang et al. 2015).

In the discipline of IS/IT, readiness or e-readiness refers to the ability and capability of an organization to adopt and benefit from IT/IS technology (Choucri et al. 2003). AI, in the broadest sense, is about the skills, data, processes, structures, and strategies of an organisation (Salleh et al. 2011). AI-readiness therefore involves more than just AI technology. However, due to many factors such as unclear relative advantage for AI and lack of AI skills (Curran & Purcell, 2017), many organisations still challenge the adopters of AI. In response to this, AI-readiness refers to the preparedness of organisations to implement change involving applications and technology related to AI. To analyse the perspective of a firm's adoption of AI, we consider two theoretical frameworks: TOE and DOI. The Technology-Organization-Environment (TOE) framework (Tornatzky and Fleischer, 1990) is a multi-perception theory developed to provide a framework for investigating the adoption of IS at the firm level. On the other hand, the Diffusion of Innovation theory (DOI) seeks to explain 'how, why and at what rate new ideas and technology spread' (Rogers, 1995). Both theories are similarly applied to adopting new innovation at firm level (Oliveira & Martins, 2011).

Rogers (1995) studied how new ideas are communicated through a culture and found a basic pattern that was almost universally present as innovation ideas diffuse through a culture. DOI adoption of innovation at firm level depends on individual characteristics (such as the leader), internal characteristics and external characteristics of the organization (Rogers, 1995). DOI theory determines five characteristics of a new innovation that may be essential for adoption of new innovation: relative advantage, compatibility, complexity, trialability, and observability. Relative advantage refers to the degree of additional benefits in comparison with current innovation. Compatibility is about how well an innovation fits with the organisation's values and needs. Complexity refers to the difficulty of understanding and adopting the innovation. Trialability refers to the ease of use and testing of the innovation. Observability is the extent to which the potential innovation is perceptible (Rogers, 1995). Several IS studies have investigated DOI at firm level in different areas, such as adoption of e-business (Zhu et al.2006), enterprise resource planning (Bradford and Florin 2003) and cloud computing (Yang et al. 2015).

The TOE framework is used at the organisational level to explain factors that influence adoption decisions. Tornatzky and Fleischer (1990) found that the decision to adopt an innovation at the firm level is not only built on technological factors but is also influenced by organisational and environmental contexts. As its name suggests, the TOE framework analyses a firm from three different dimensions: technology, organisation and environment. The technological dimension includes all the relevant technologies available within and outside the firm. The organisational dimension describes business characteristics and resources that might influence the adoption process such as firm size, managerial structure, decision-making and communication. The environmental dimension refers to the structure of the industry including the firm's competitors, suppliers, customers and regulatory environment (Tornatzky & Fleischer 1990). To date, the TOE theory has been widely examined in ICT and other disciplines such as e-commerce (Oliveira & Martins, 2011) and enterprise resource planning (Bradford and Florin 2003). Other fields where it has been tested include e-maintenance (Aboelmaged, 2014), cloud computing (Yang et al. 2015), e-marketing (Duan, 2010; Yan et al. 2009; Zhai, 2010), e-business (Ifinedo, 2005; Molloa et al.2010) and e-commerce (Idris, 2015). The TOE framework has also been tested in various fields including e-maintenance (Aboelmaged, 2014), cloud computing (Yang et al. 2015), e-marketing (Yan et al.2009), e-business (Ifinedo, 2005) and e-commerce (Idris, 2015). However, to the best of our knowledge, TOE has not previously been used to study the adoption of AI at firm level. Results from existing research show that the TOE framework is suitable for investigating innovation adoption at an organisation level (Aboelmaged, 2014). As a result, for AI adoption, we can apply the e-readiness factors as AI-readiness with some modifications. For instance, in AI adoption people issues and IT infrastructure resources must also be considered because this correlates significantly with AI technology and concepts (Oxborough et al. 2016). Therefore, we suggest that human, enterprise and

technology resources are critical factors for AI-readiness.

Framework and Hypotheses Development

The fundamental concept of the proposed framework is that aspects of technological, organizational and environmental factors are essential for AI adoption. It presents the research hypotheses from the perspectives of technological readiness, organisational readiness and environmental readiness. According to Webster & Watson, (2002) research framework and hypotheses need to be justified based on a theoretical explanation, practice from past empirical findings and empirical findings from related research areas. Unlike other adoption theories, the TOE framework does not specify a set of factors that affect innovation adoption (Aboelmaged, 2014). Therefore, the factors we have chosen are assumptions based on past experience and practice from related research area as discussed in the section above.

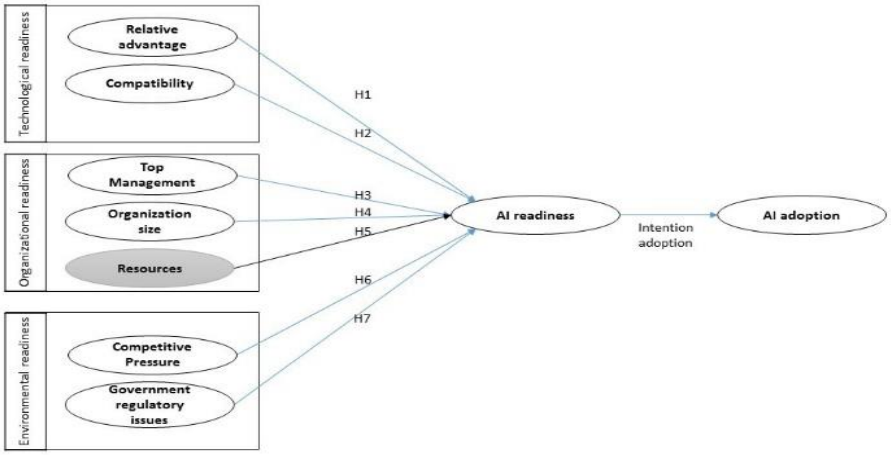

Figure 1: Research framework for AI adoption at firm level (Adapted from the TOE framework)

Technological readiness

Technological readiness refers to the ability of a firm to adopt new technology (Richey et al. 2007). This includes both internal (technology infrastructure) and external (existing in the market) technologies that are relevant to the firm. The firm must carefully consider the complexities and challenges of adopting new technology. Therefore, technological readiness offers a better way to foretell the benefits gained from technological implementation (Richey et al. 2007). Technological readiness in Figure 1 refers to how firms are prepared to adopt AI technology.

Relative advantage

Relative advantage refers to the perceived benefit of adopting AI at the firm level. In the context of this research, perceived AI benefits refers to the degree to which AI is better than other competing technologies (Zahi, 2010). Rogers (2003) outlined that the perceived benefit of an innovation has a significant effect on an organisation's intention to adopt an innovative technology. Prior research (Aboelmaged, 2014; Kumar et al. 2016; Hung, 2016; Ifinedo, 2005; Zhai, 2015; Yang, 2015) also found a positive relationship between the relative advantage of new technology and the acceptance of an innovation. AI allows an organisation to obtain a competitive advantage, reduce costs (Press, 2016) and opportunities to transfer into new businesses (Ransbotham et al. 2017), raise top-line profits, increase efficiency and amplify human intelligence (Curran & Purcel, 2017). Technology such as deep learning (DL), natural language generation (NLG) and machine learning (ML) allow firms to have a competitive advantage (Curran & Purcel, 2017) when adopting AI, which leads to the following hypothesis:

H1: The relative advantage of AI technology positively influences AI-readiness.

Compatibility

A significant number of studies have shown a positive relationship between compatibility and intention to adopt an innovation (Ifinedo, 2005; Yang, 2015; Yan, 2009; Zahi, 2010). Compatibility refers to the extent of the innovation and its ability to provide value and experience while addressing the needs of the expected adopters (Rogers, 1995). Chui (2017) stated that successful AI transformations require a solid AI business case and should align with existing strategies. Ifinedo (2005) found that a greater match between the adoption process and the diffusion of technology innovation leads to an easier adoption. Thus, this research posits the following hypothesis:
H2: Compatibility between the AI business case and an organisation's existing strategies positively influences AI readiness.

Organisational Readiness

Adoption of new innovation is influenced by organisational characteristics such as firm size, top management etc. (Wade & Hulland, 2004). Iacovou et al. (1995) define organisation readiness 'as the availability of the needed organizational resources for adoption.' Based on previous studies of new innovation (Duan,2010; Hung,2014; Idris,2015; Zahi,2010; Yan et al.2009; Yang et al.2015), this study uses top management support, firm size and resources as factors of organisational readiness.

Top management support

Top management support refers to the engagement of a top-level leader for IS/IT implementations (Ifinedo, 2005). Resource-based theory identifies top management support as a moderating factor and claims that a lack of support not only fails to improve a firm's competitive position but also increases its failure to adopt an innovation (Wade & Hulland, 2004). Top management commitment can also have a significant positive influence on new technology adoption (Hung et al. 2014; Zahi, 2010; Yang et al. 2015) in terms of articulating a vision (Yang et al. 2015), providing capital funds (Hung, 2016) and allocating resources. For example, for research into IS/IT adoption, top management support was shown to promote the acceptance of cloud computing (Yang et al. 2015) and e-business (Ifinedo, 2005). In general, applying AI to drive the business transformation is a strategic decision (Gartner, 2017b). The following hypothesis is therefore proposed:
H3: Top management support positively influences AI readiness.

Organization size

Rogers (2003) stated that the size of the organisation directly affects the adoption of innovation. Several studies found that firm size has a positive effect on adopting new innovations (Aboelmaged, 2014; Duan, 2010; Zahi 2010). Duan (2010) found that large organisations have a greater ability to adopt technology. Likewise, Zahi (2010) pointed out that large firms face greater competitive pressure and Aboelmaged (2014) reported that the positive impact of firm size is because larger organisations have more financial and technical resources. This research thus posits the following hypothesis:
H4: Firm size positively influences AI readiness.

Resources

Besides organisational readiness factors, human, enterprise and information technology resources are also critical to adopting a new innovation at the firm level (Iacovou et al. 1995). Technology resources refer to computer hardware, data, and networking that are essential to adopt new innovation (Aboelmaged, 2014). In the context of AI, many current AI technologies begin with standard machine learning algorithms and then become intelligent after being trained (Ransbotham et al. 2017). A new report from Narrative Science, (2016) indicates that 59% of organisations that are skilled in big data are also using AI Technology. Hung et al.2014 classified resources into employees and technologies. According to a recent survey, most organisations struggle to adopt AI and smart machines because they focus on technology rather than adequate skills and methodologies for implementation (Gartner, 2017a). A significant amount of empirical IS research has shown that firms with human, enterprise and

technology resources increase their readiness to adopt innovation such as websites (Hung et al.2016), e-maintenance (Aboelmaged, 2014) and e-business (Wang and Cheung, 2008). Accordingly, this research hypothesizes that resources positively influence AI readiness.
H5: Human, enterprise and technology resources positively influence AI readiness.

Environmental readiness

Generally, organisations conduct their activities in response to their environmental conditions. This includes the area in which a firm conducts its business with its competitors in the same space (Tornatzky and Fleischer1990). Environmental readiness refers to how the organisation perceives external factors to adopt AI. Research has shown that external factors such as competitive pressure and regulatory issues are driving factors for adopting new innovation (Ifinedo, 2005). For the adoption of AI, this study includes two relevant environmental factors; competitive pressure and government regulations.

Competitive pressure

Competitive pressure refers to the threat of losing competitive advantage, which motivates an organisation to adopt a new innovation (Aboelmaged, 2014). Considerable empirical research has recognised competitor pressure as a factor for the diffusion of a new innovation (Yang, 2015). Hung et al. (2016) pointed out those business activities that are affected by external circumstances such as socio-economic factors. According to a recent report by Gartner (2017a), developing an AI strategy is the top strategy for technology progression in 2018. AI has the capability to spur innovation and create new opportunities for both individuals and organisations (Fast & Horvitz, 2017). The ability to use AI to improve decision-making and customer experience influences the adoption of AI (Garten, 2017a). Hence, this study proposes the hypothesis:
H6: Competitive pressure has a positive influence on AI readiness.

Government regulatory issues

In addition to competitive pressure, government policy has been recognized as one of the factors that firms need to consider (Hung, 2014). In this study, regulatory issues refer to the assistance provided by the government authority to encourage the adoption of AI innovations at organisation level. In the context of AI, different governments have different policies. For example, in the United States, preparations are being made to adapt regulatory challenges to those 'AI-enabled' products such as self-driving cars to encourage AI innovation (Hill, 2016). Hence, this study proposes the hypothesis:
H7: Government regulations can have a positive influence on AI readiness

Proposed Methodology and Future Work

The focus of this in-progress-research is to develop an AI-readiness framework like a capability maturity model at firm level. The next steps include validation of the framework over a set of organisations to identify factors which impact AI adoption. The target population of this study is C-level and intermediate executive in charge of information system of SMEs in both private and public service organizations in Australia. A quantitative approach using an online survey instrument will be the preferred method for data collection to test the theoretical framework. A 5-point Likert scale will be used to measure the items which are acceptable for large sample sizes. The proposed research question aims to determine factors that influences an organisation's readiness for AI adoption.

Expected Contribution

Recent emergence of AI in society has presented a number of challenges, particularly at firm level. From the theoretical side, this study will contribute to the IS body of knowledge through exploration of the innovation of technology adoption theory and by identifying factors affecting an organisation's readiness for AI. On the practical side, this study provides insight into AI adoption by helping organisations to be prepared and successful in implementing this 'old' but emerging technology.

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